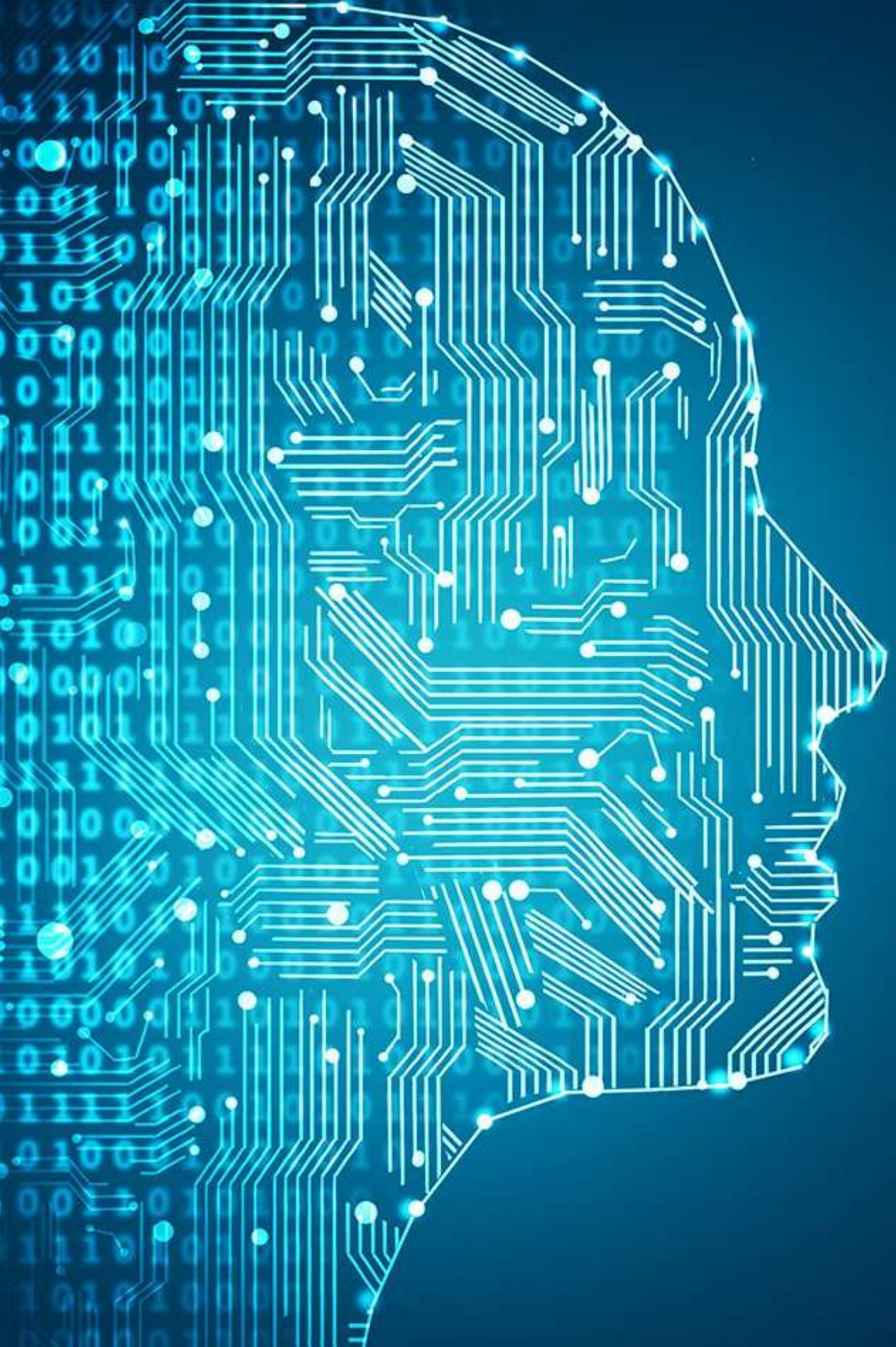
Machine y Deep Learning en Radiología: ¿Cuál es el papel del radiólogo?

David Molina-García

MATHEMATICAL ONCOLOGY LABORATORY

UCLM
UNIVERSIDAD DE CASTILLA-LA MANCHA



Machine learning

Arthur L. Samuel

Google

amazon

NETFLIX

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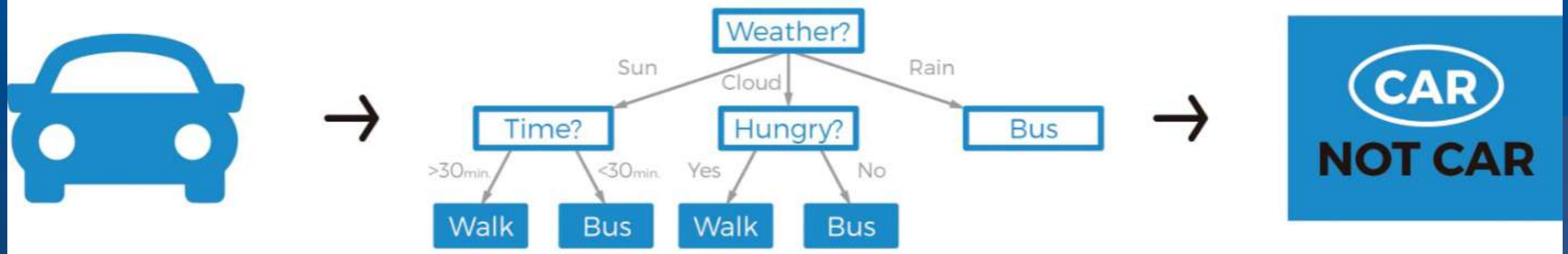
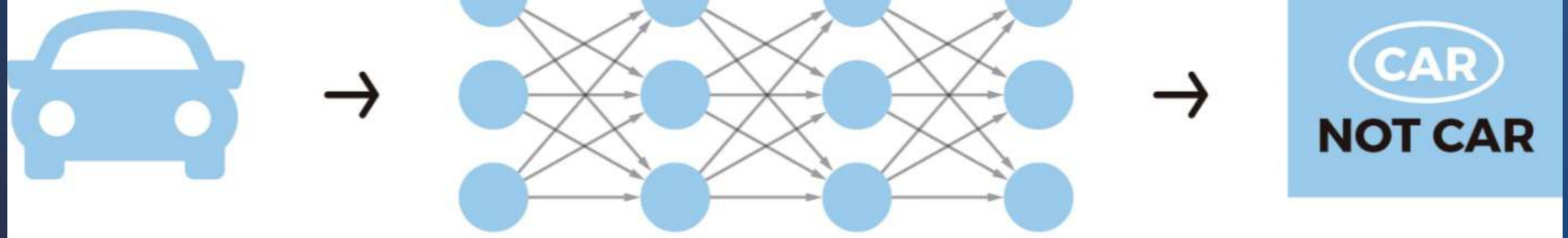
Machine Learning

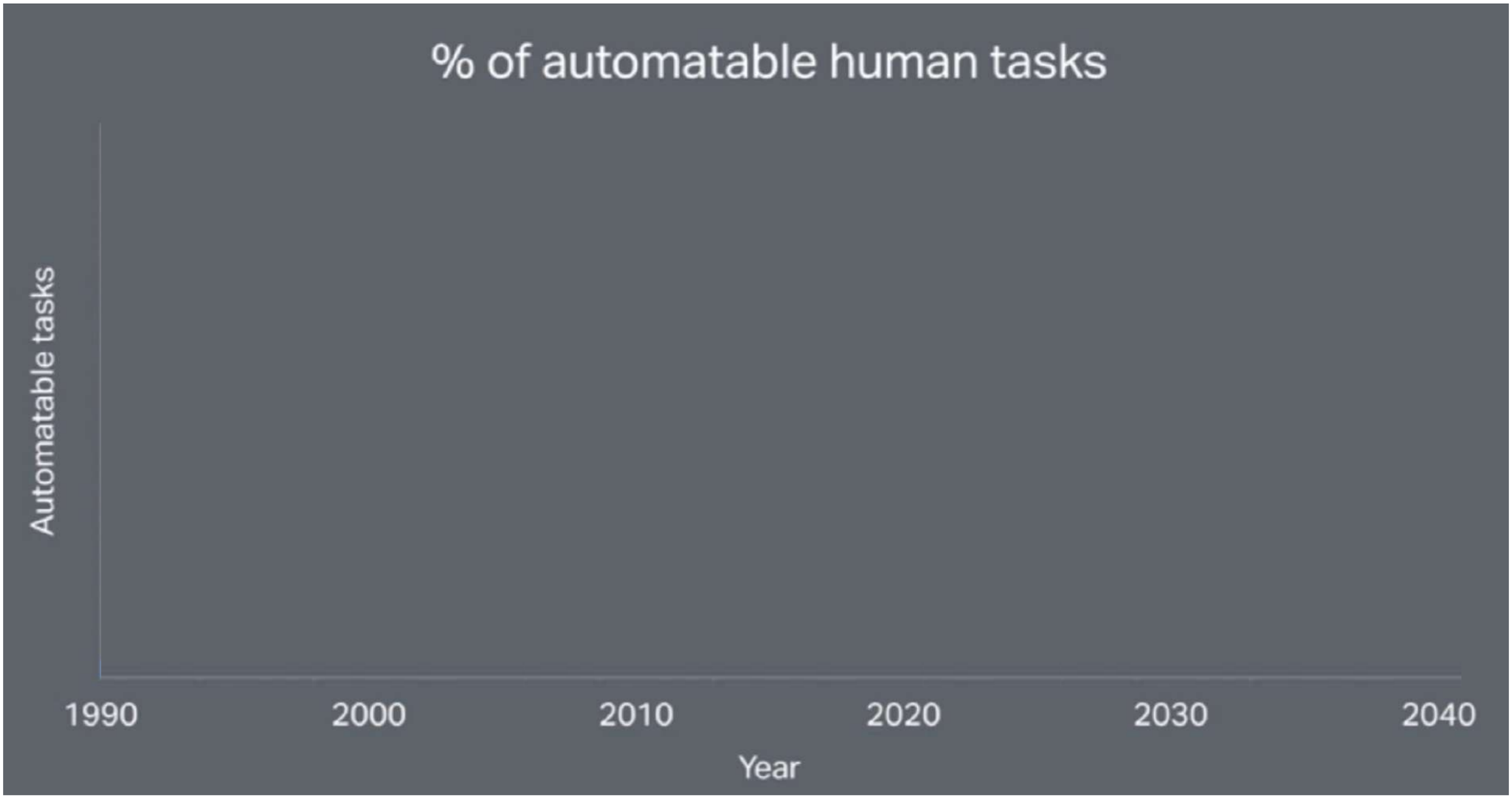


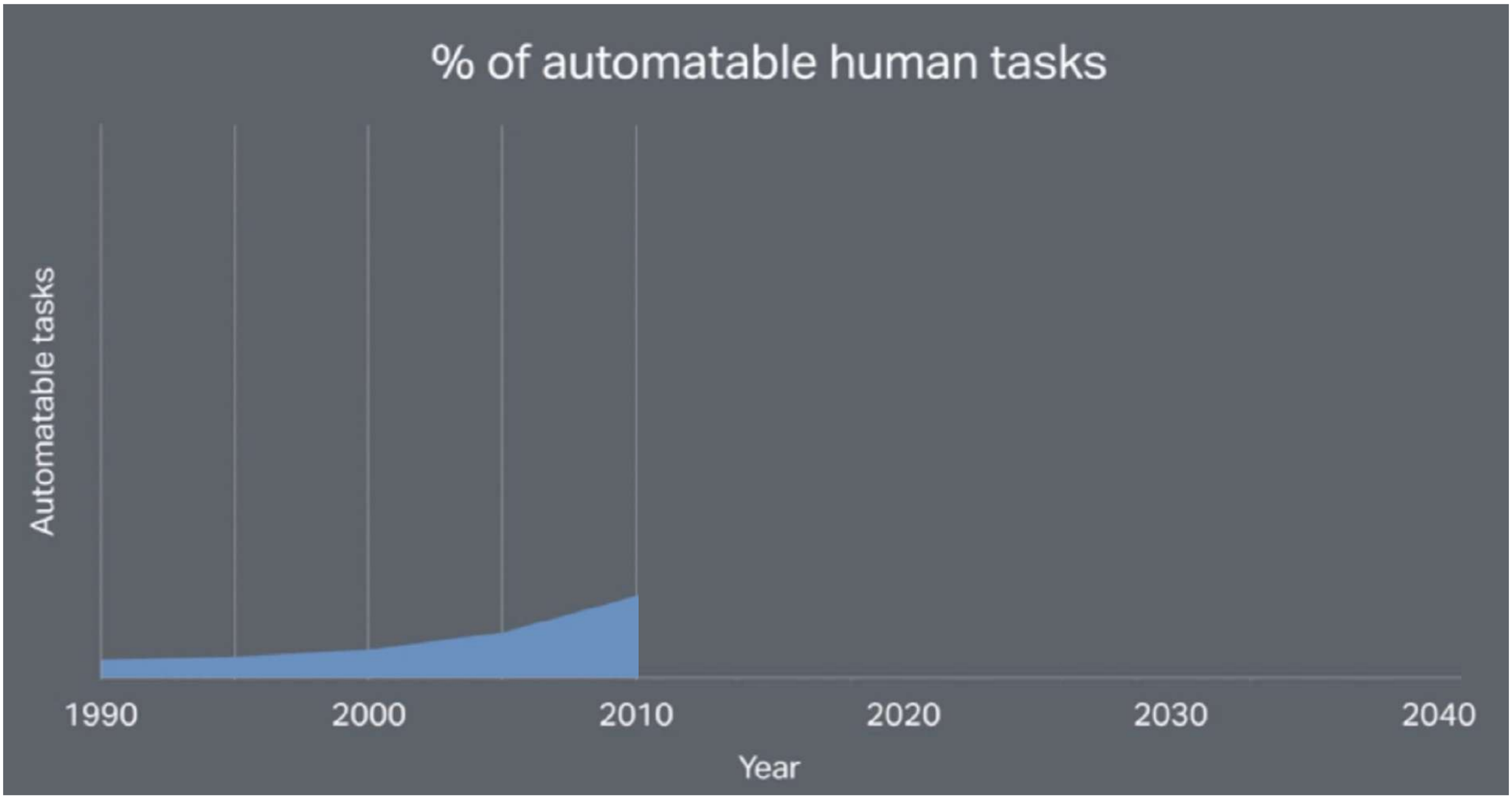
Input → Decision tree → Output

Deep Learning



Input → Feature extraction + Classification → Output


% of automatable human tasks
Automatable tasks
1990
2000
2010
2020
2030
2040
Year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Year

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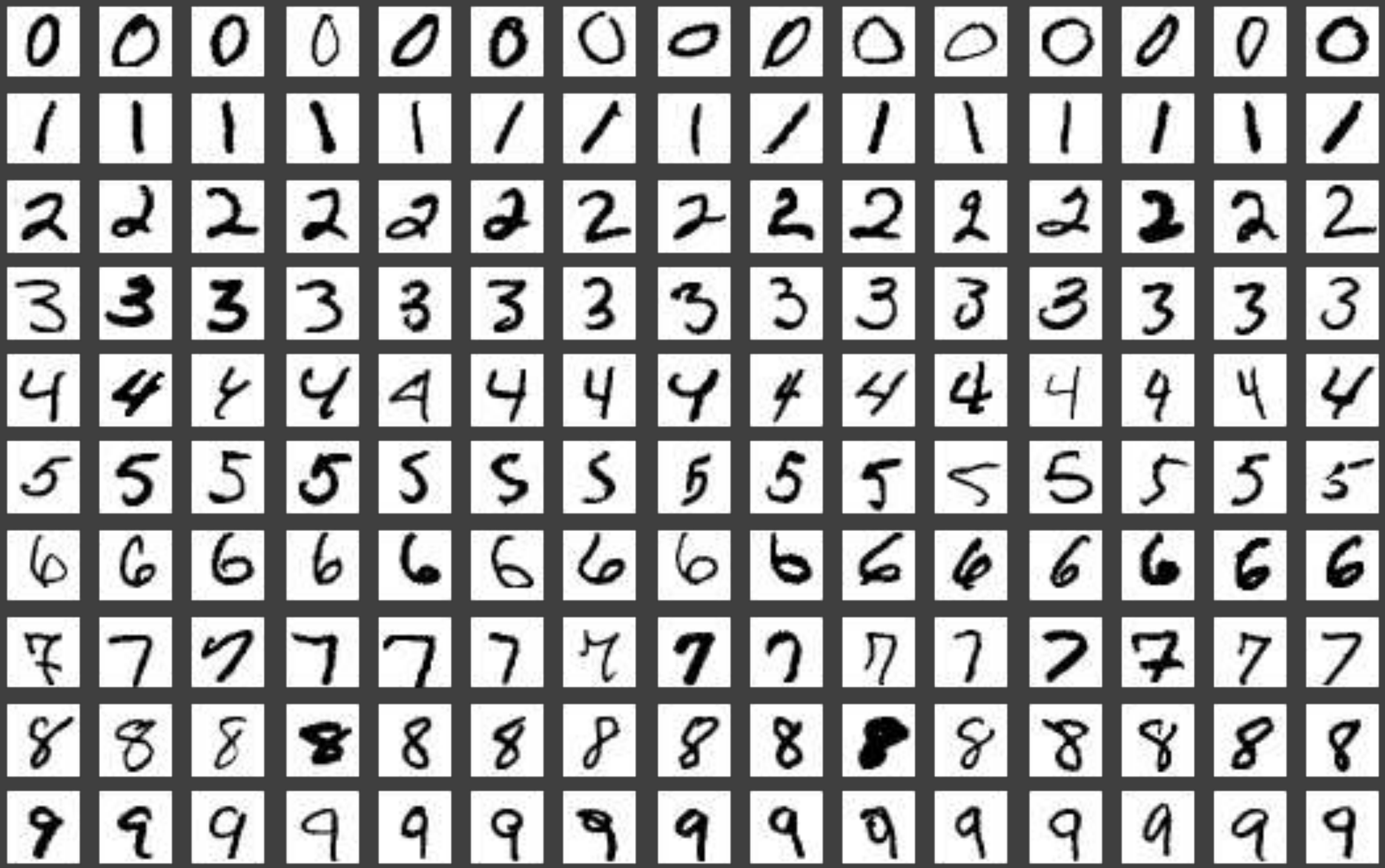
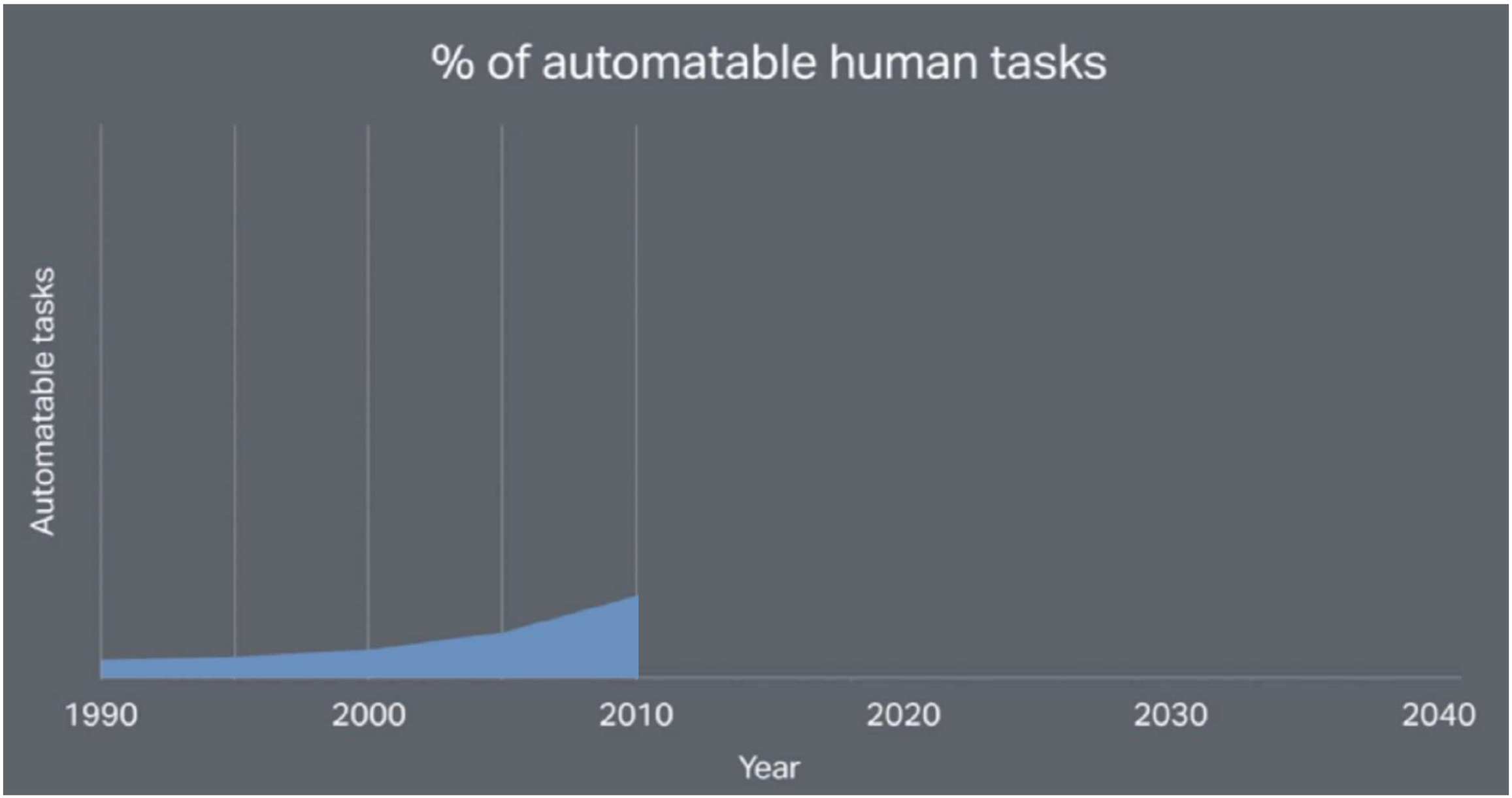
OOH 848Y

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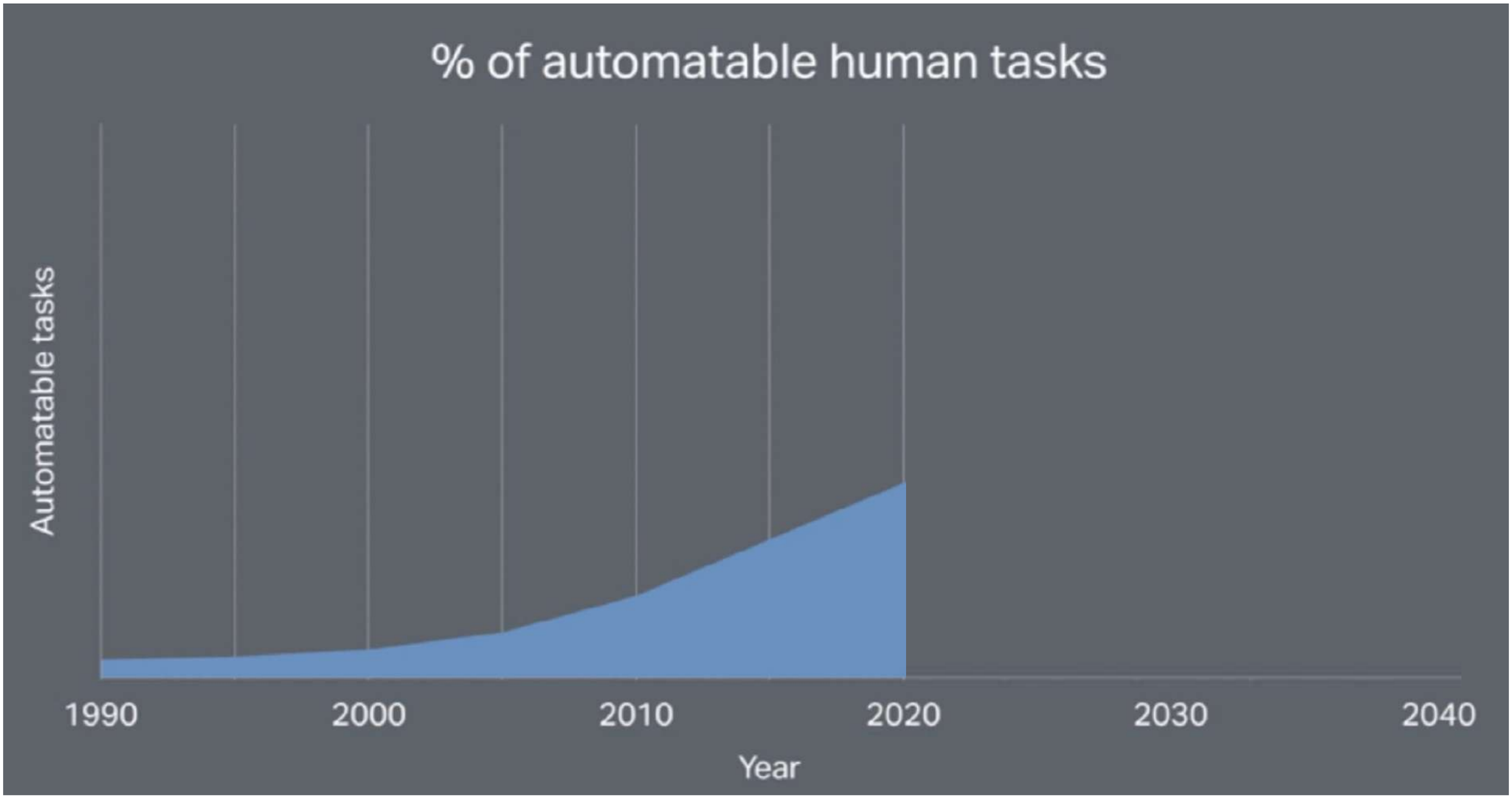
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Year

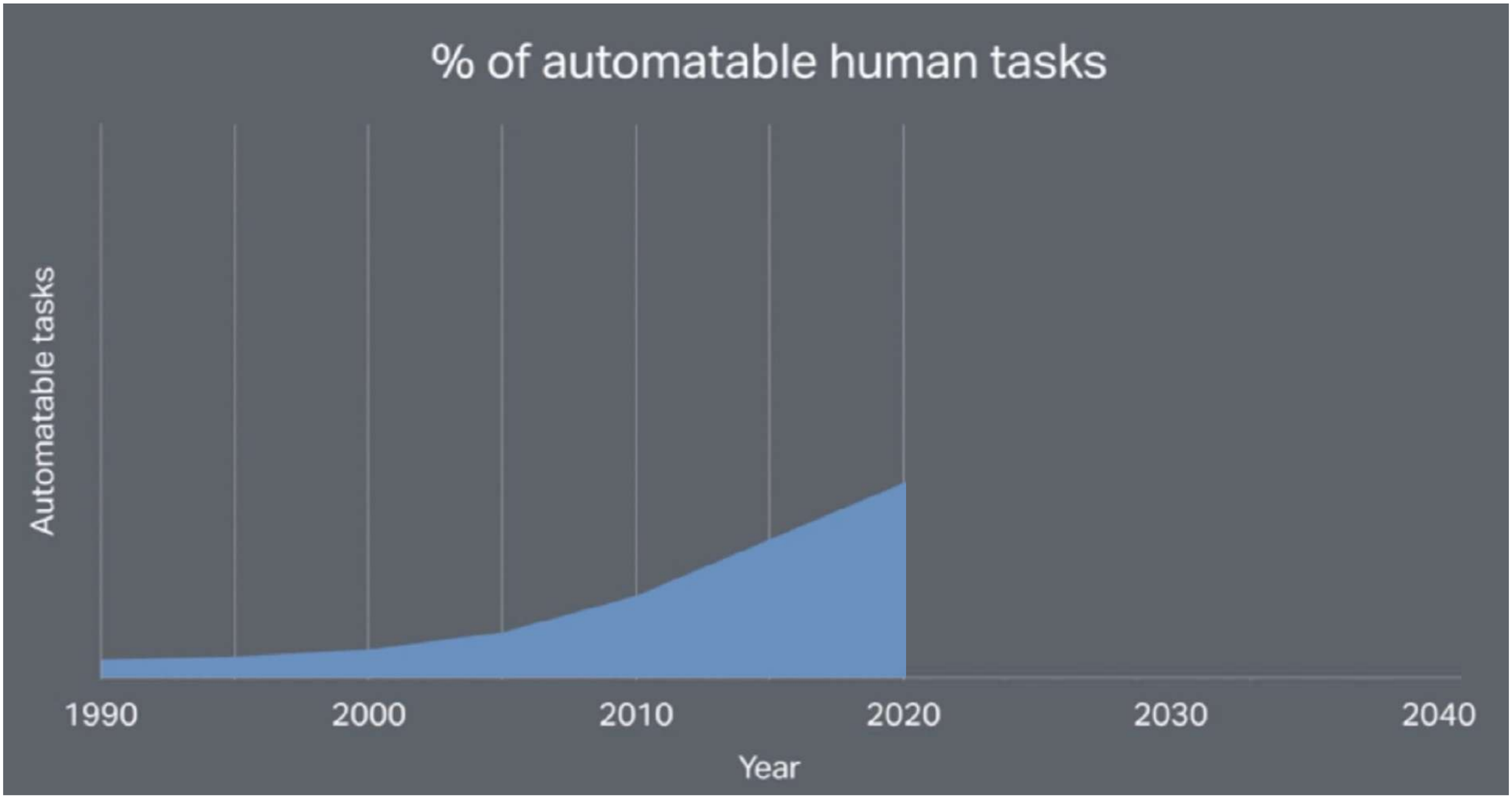
Éxito

B+

RECONOCER ALGUNA DEL TREN. CUANDO ENTRO LAURA LA SALVE ENSEGUIDA, CASI ME MUERO DE ALEGRIA, ERA LA MOROCHA QUE YO LE HABIA CALCULADO UNOS VEINTE AÑOS, LA QUE TENIA UNA CADENITA CON LA CRUZ QUE SE PERDIA EN EL ESCOTE. ENTRO MIRANDOME SONRIENTE, DIVINA, UN BOMBONAZO DE MUJER.
– HOLA FERNANDO – ME DIJO MOSTRANDOME MI TELEFONO.
YO ME PARE AL TOQUE, RECIBI EL CELU, Y LE CORRI LA SILLA INVITANDOLA A SENTARSE COMO TODO UN GENTLEMAN. ACEPTO, SE SENTO Y YO HICE LO MISMO FRENTE A ELLA.
– HOLA LAURA, ANTES QUE NADA DEJAME QUE TE AGRADEZCA UNA VEZ MAS POR TU GESTO
– NO, NO ES NADA
– NO SERA NADA, PERO TE LO PUEDO RECOMPENSAR CON UN CAFE ¿NO!? ¿TENES TIEMPO?
– SI, TENGO TIEMPO PERO PREFIERO TOMAR ALGO FRESCO – ME DIJO

CHALLENGES
AHEAD

Google
ASSISTANT
amazon alexa
Siri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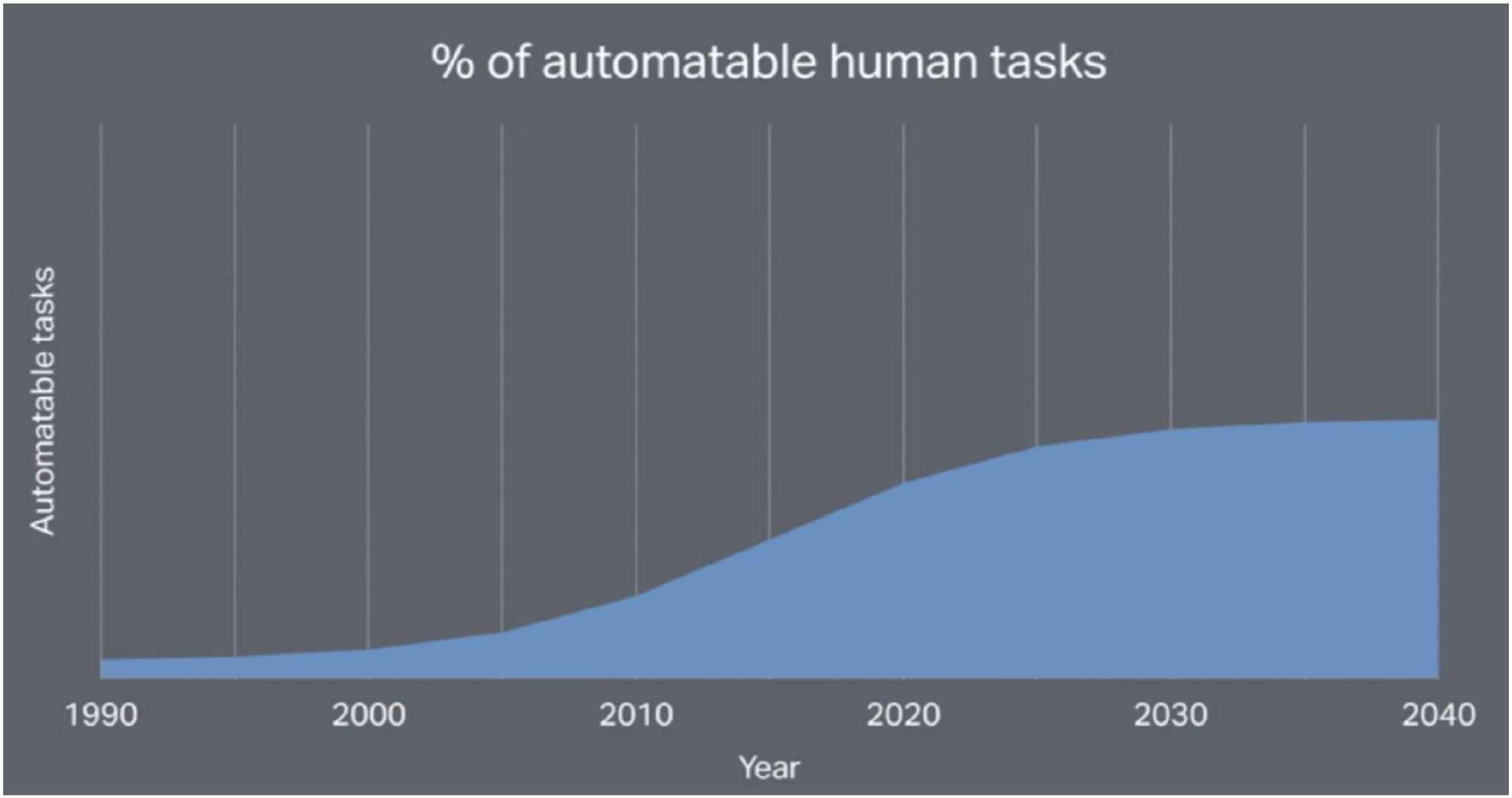
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COMPUTATIONAL AND STRUCTURAL BIOTECHNOLOGY JOURNAL

journal homepage: www.elsevier.com/locate/csbj

Review

Machine learning applications in cancer prognosis and prediction

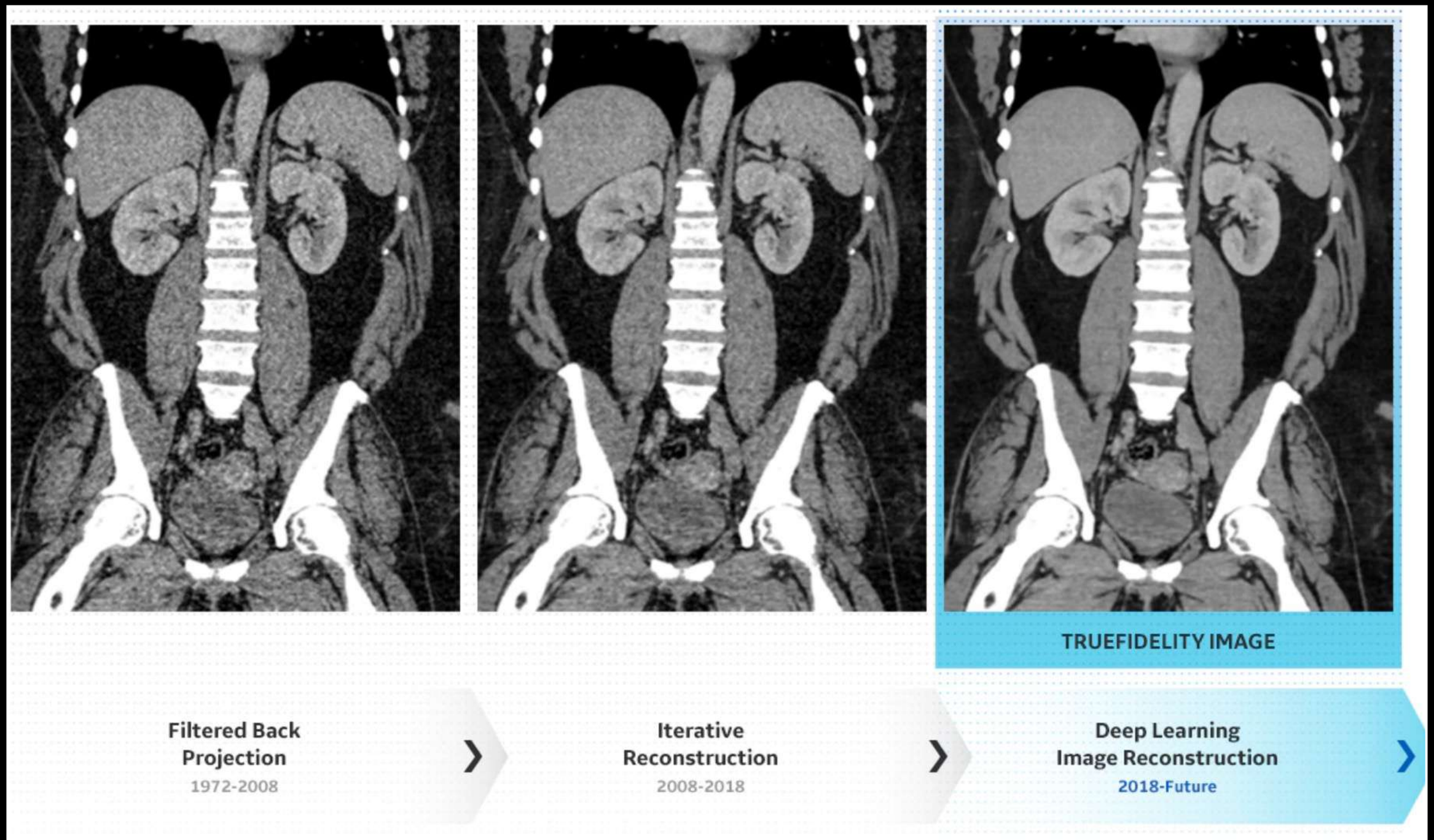
Konstantina Kourou [a], Themis P. Exarchos [a,b], Konstantinos P. Exarchos [a], Michalis V. Karamouzis [c], Dimitrios I. Fotiadis [a,b,*]

[a] Unit of Medical Technology and Intelligent Information Systems, Dept. of Materials Science and Engineering, University of Ioannina, Ioannina, Greece
[b] IMBB — FORTH, Dept. of Biomedical Research, Ioannina, Greece
[c] Molecular Oncology Unit, Department of Biological Chemistry, Medical School, University of Athens, Athens, Greece

+250 articles/year

General electric (2018)

Deep Learning Image Reconstruction



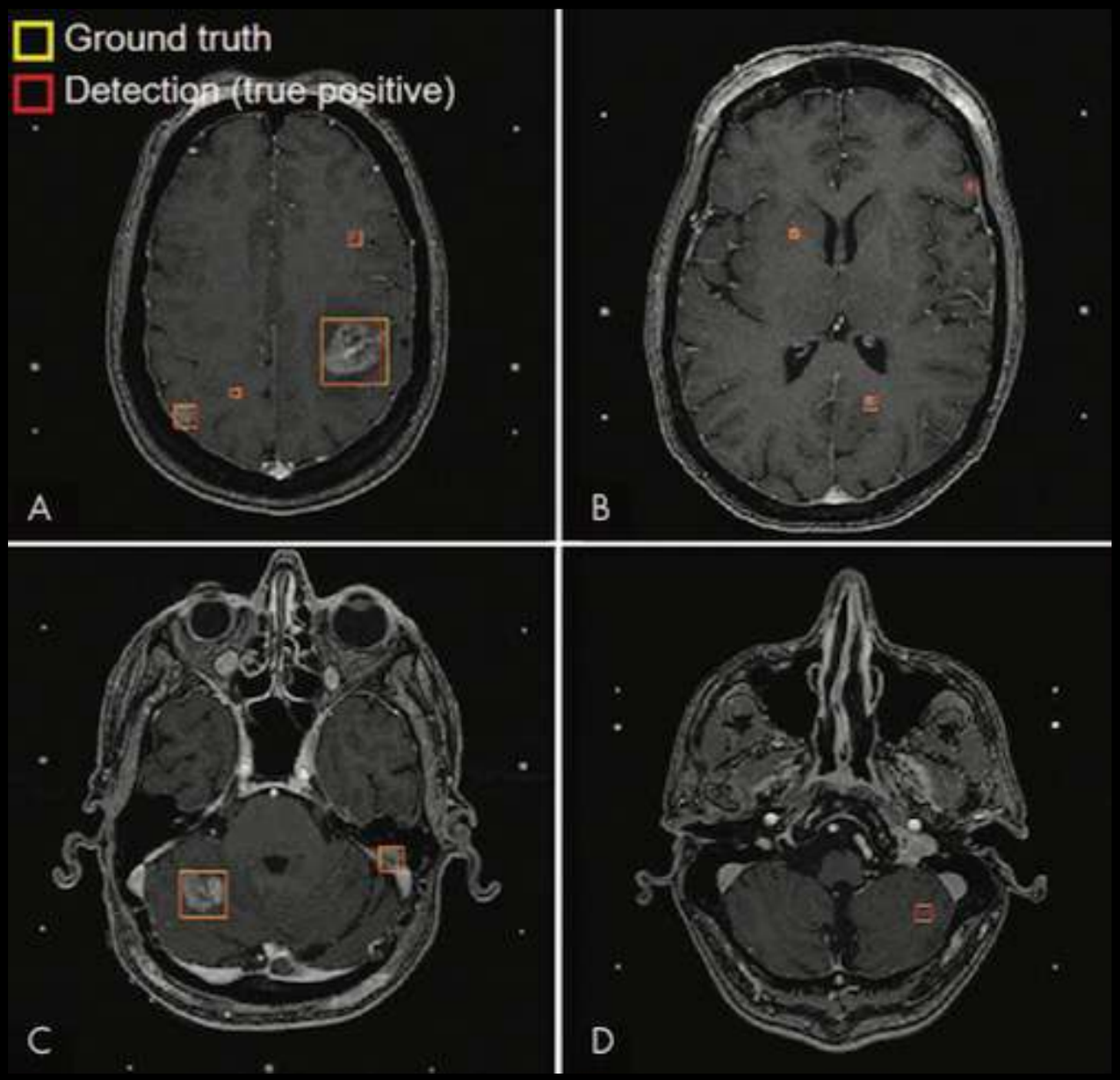
Yabu et al. (2018, The Spine Journal)

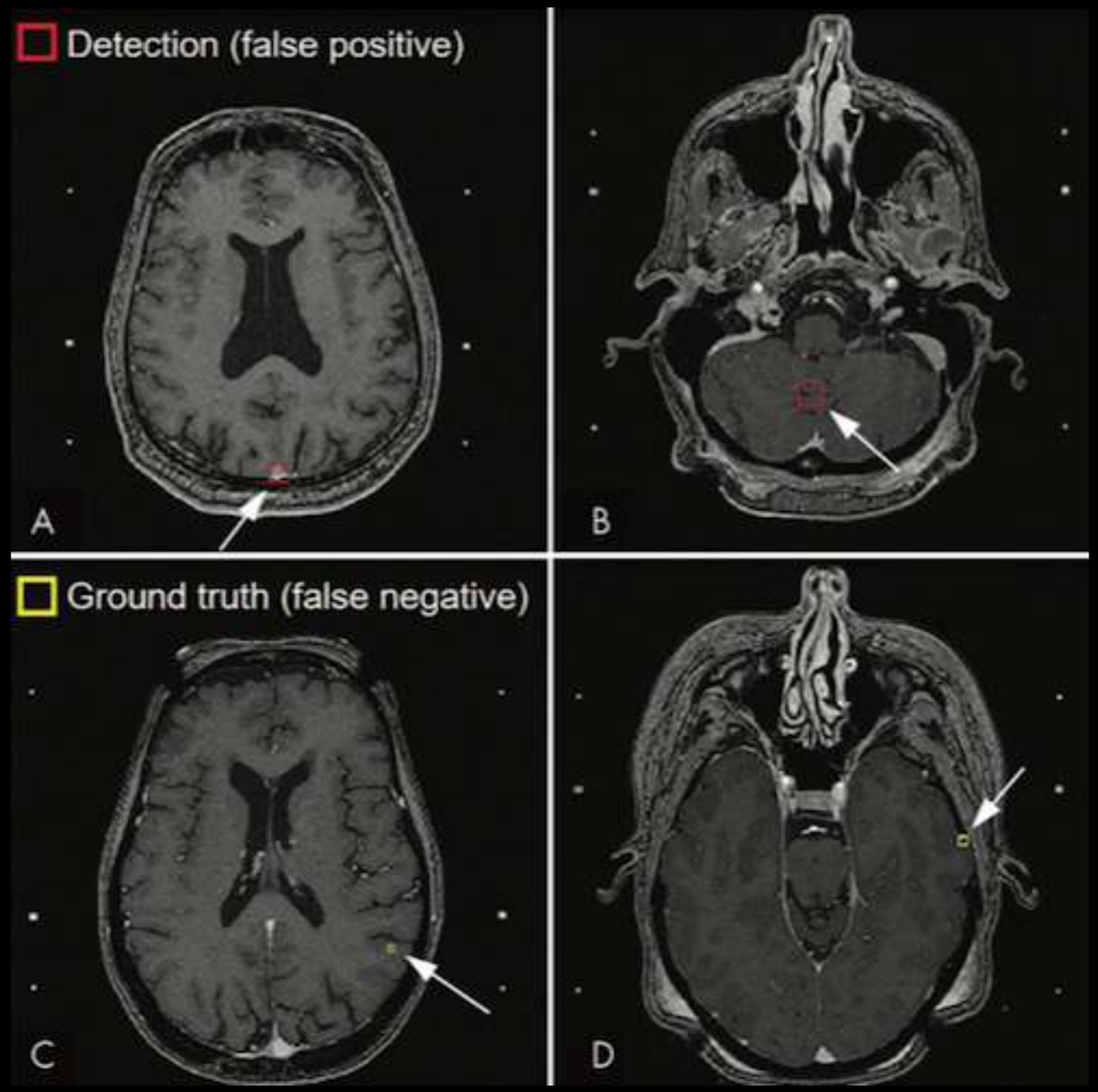
Deep Learning for osteoporotic vertebral fracture

814 patients, 95% accuracy.

Zhou et al. (2020, Radiology)

Deep Learning for detection of brain metastases

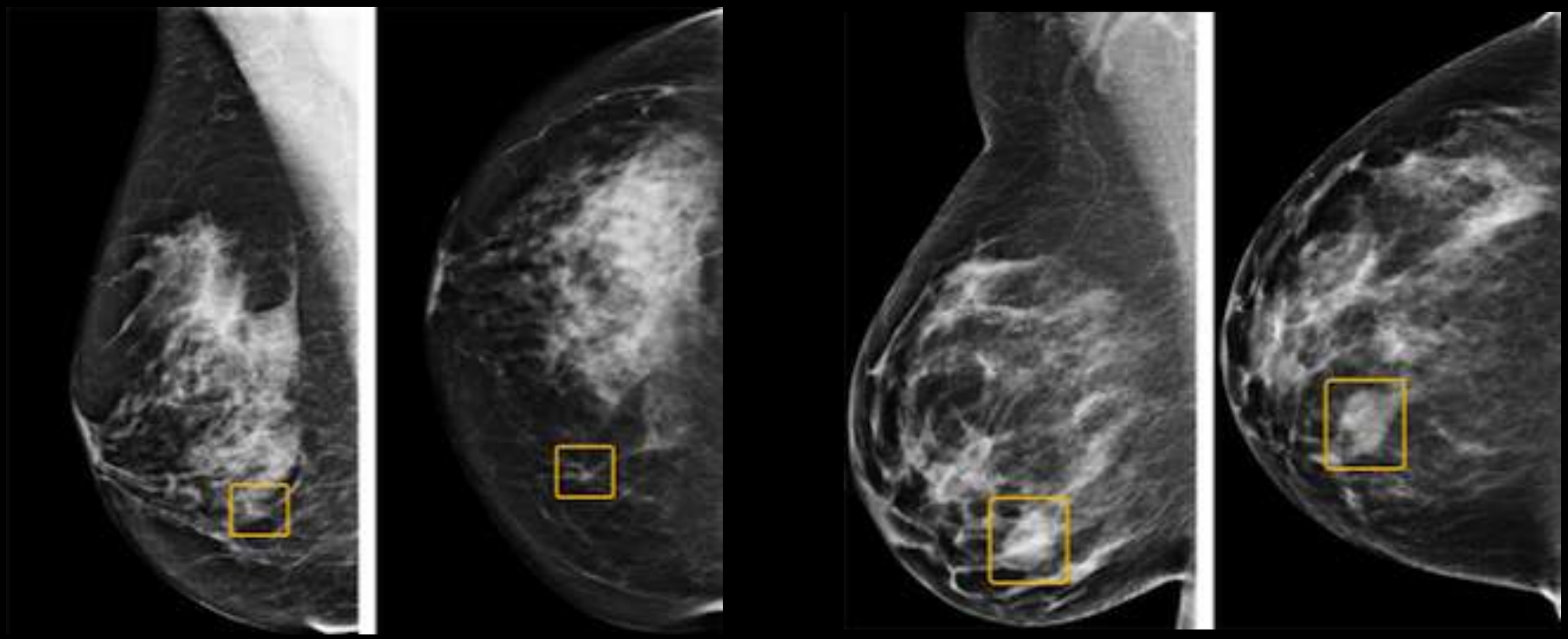




266 patients, 81% accuracy (98% if > 6 mm.)

McKinney et al. (2020, Nature)

Deep Learning for detection of breast cancer



28953 patients, same accuracy AI/reader.

AI+reader implies workfload reduced by 88%.

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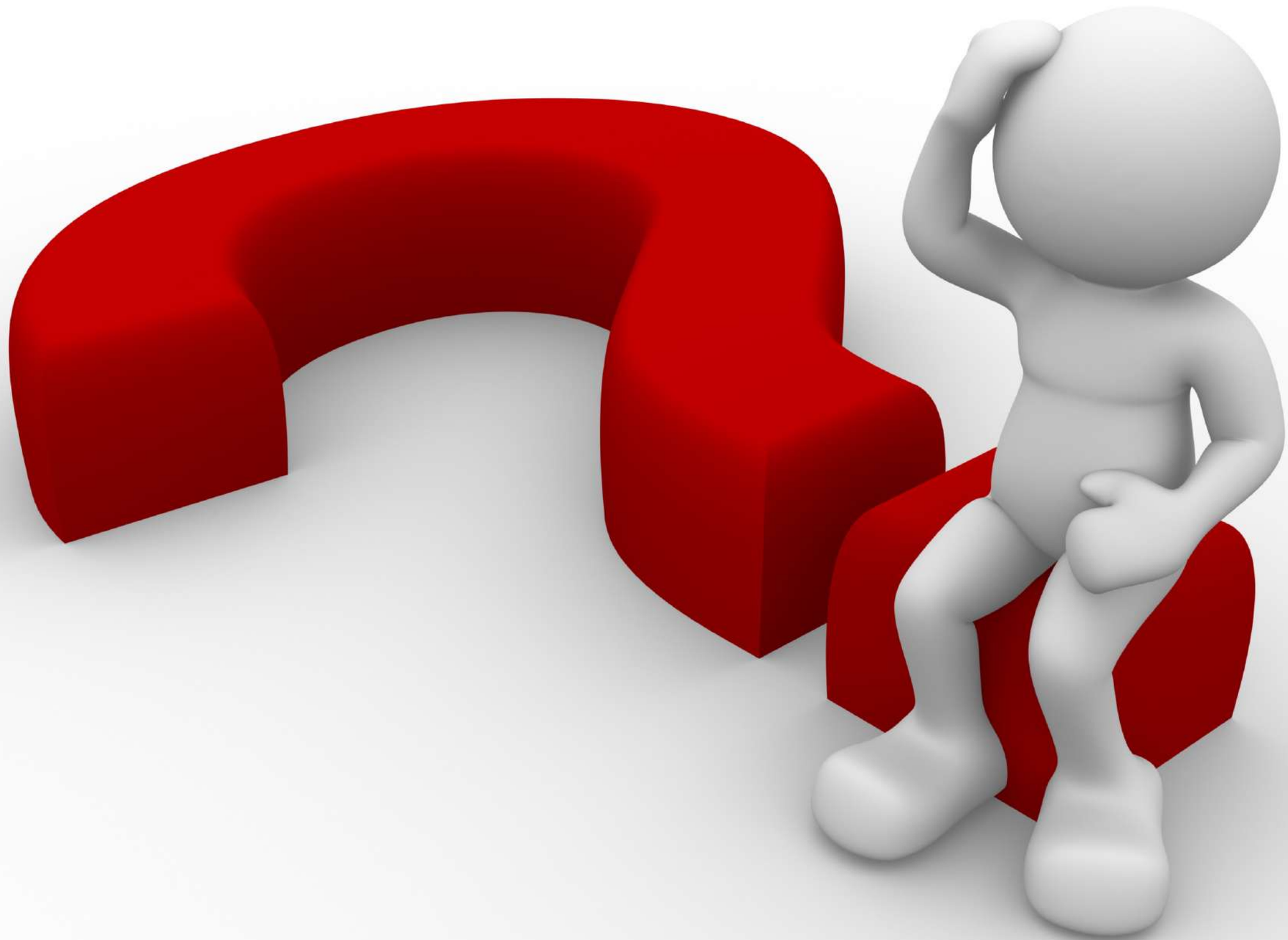
+250 articles/year

Limited real clinical applications



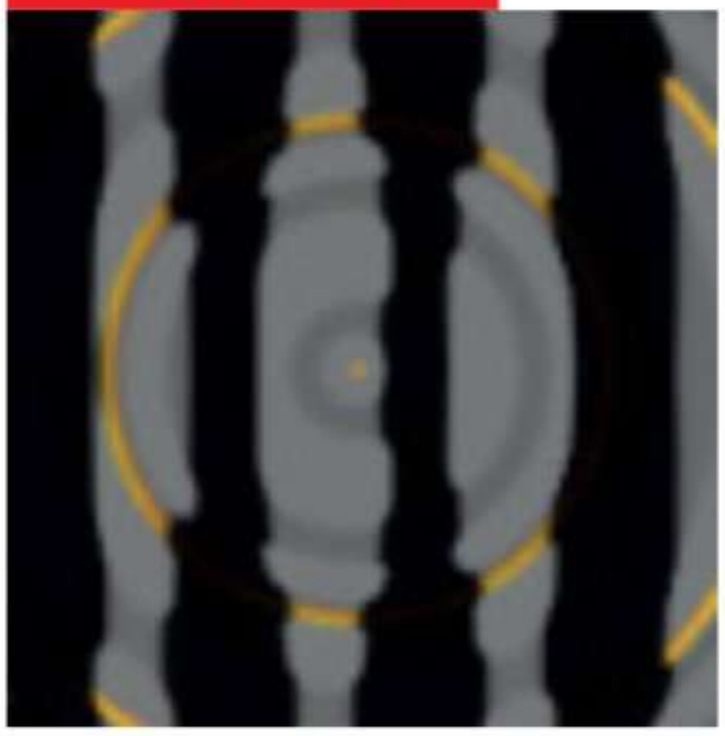
These stickers made an artificial-intelligence system read this stop sign as ‘speed limit 45’.

Stop

Speed limit 45

Scientists have evolved images that look like abstract patterns — but which DNNs see as familiar objects.

King penguin

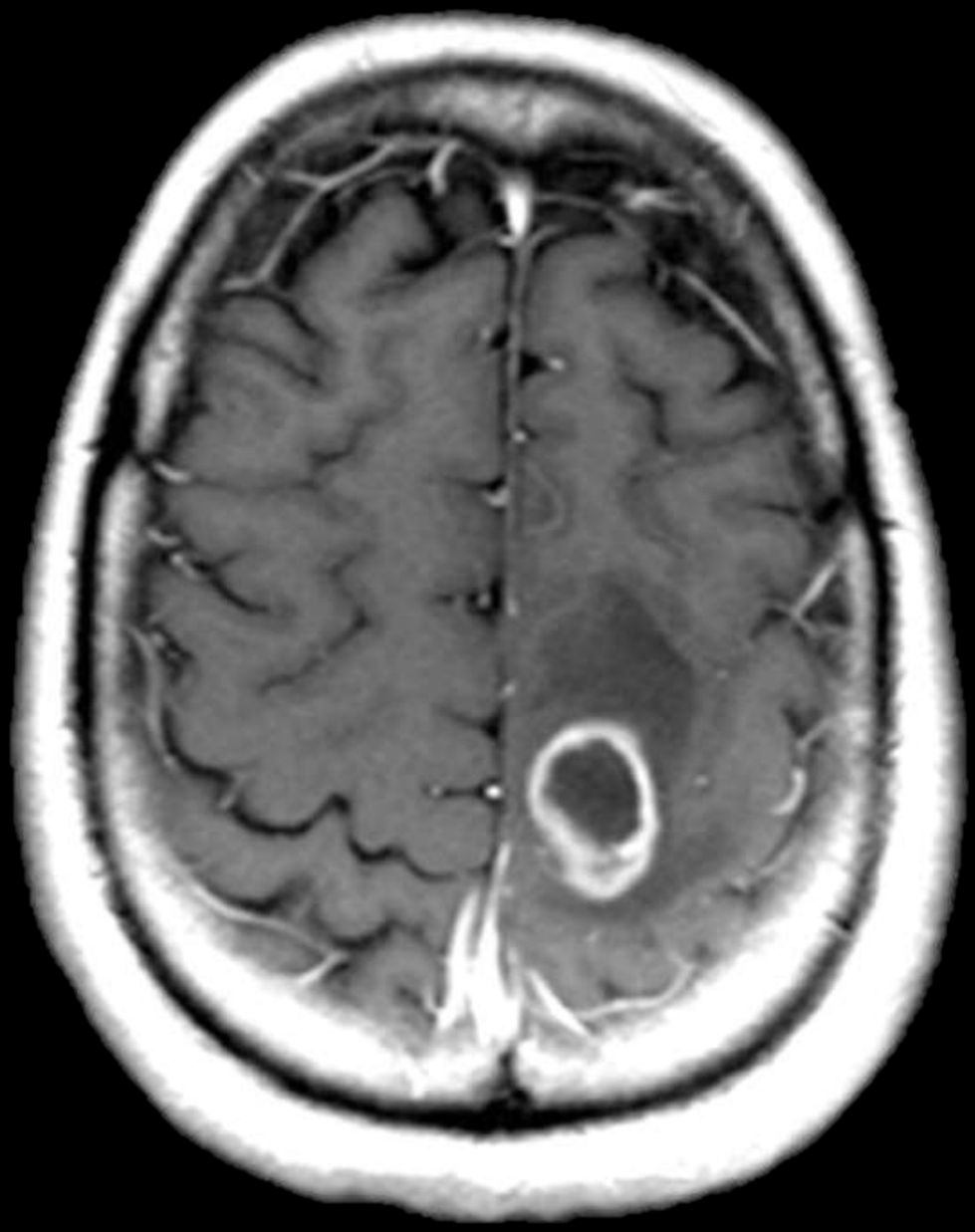


Starfish

Human versus machine

MATHEMATICAL
ONCOLOGY
LABORATORY

Automatic brain tumor diagnostician



Glioblastoma

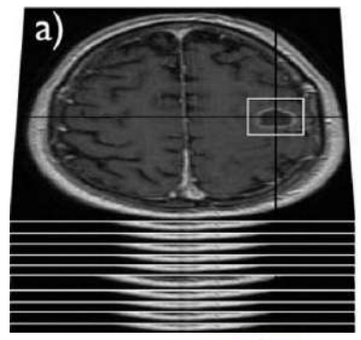
Brain metastasis

848 brain tumor patients.

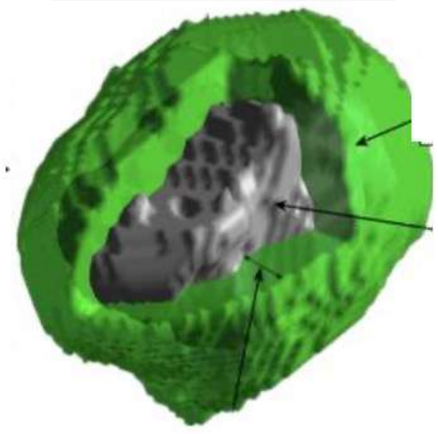
- 528 glioblastomas.
- 320 brain metastasis.

2 different methodologies

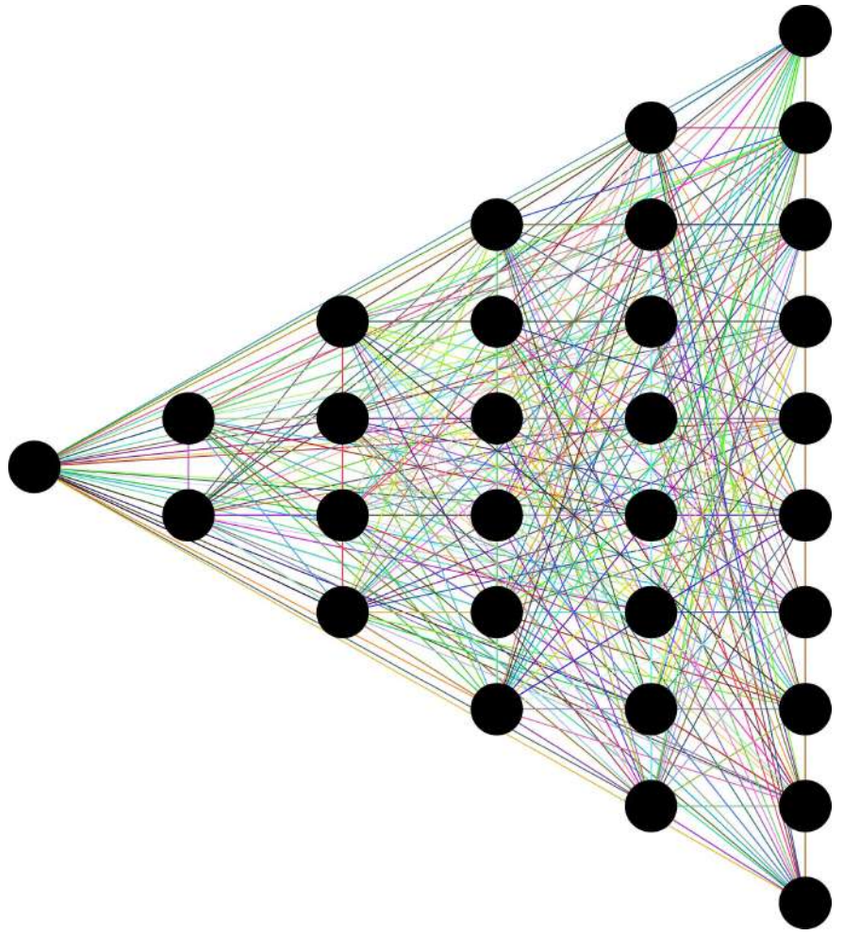
- Whole T1+Gd sequence.



- Only tumor segmentation.

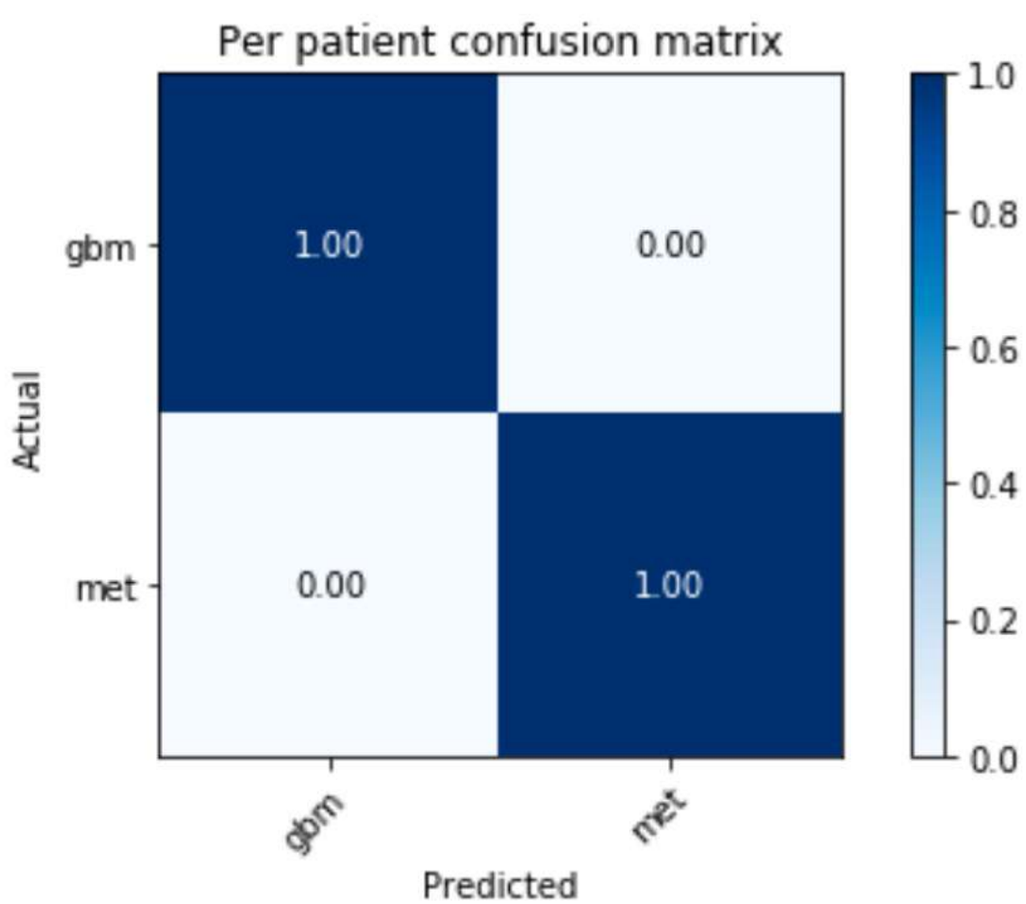


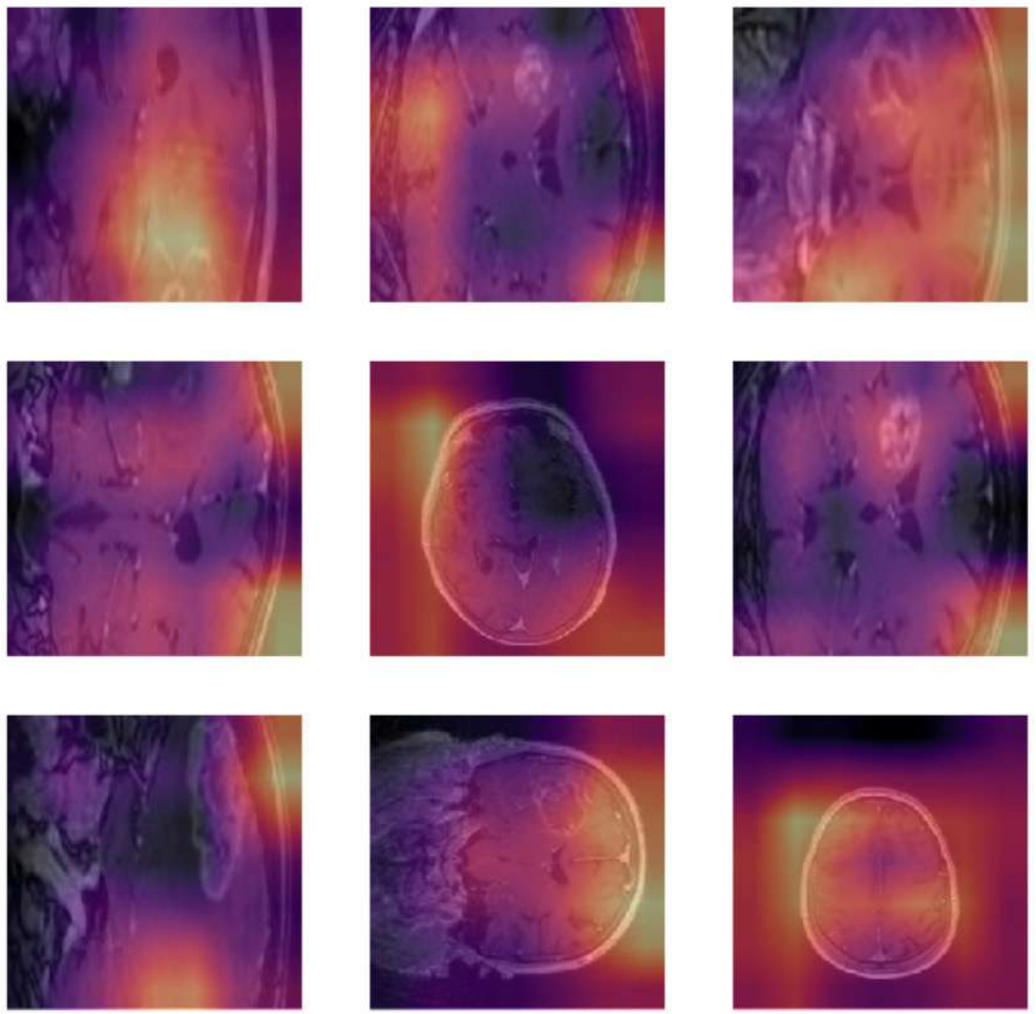
Deep learning
Convolutional neural networks



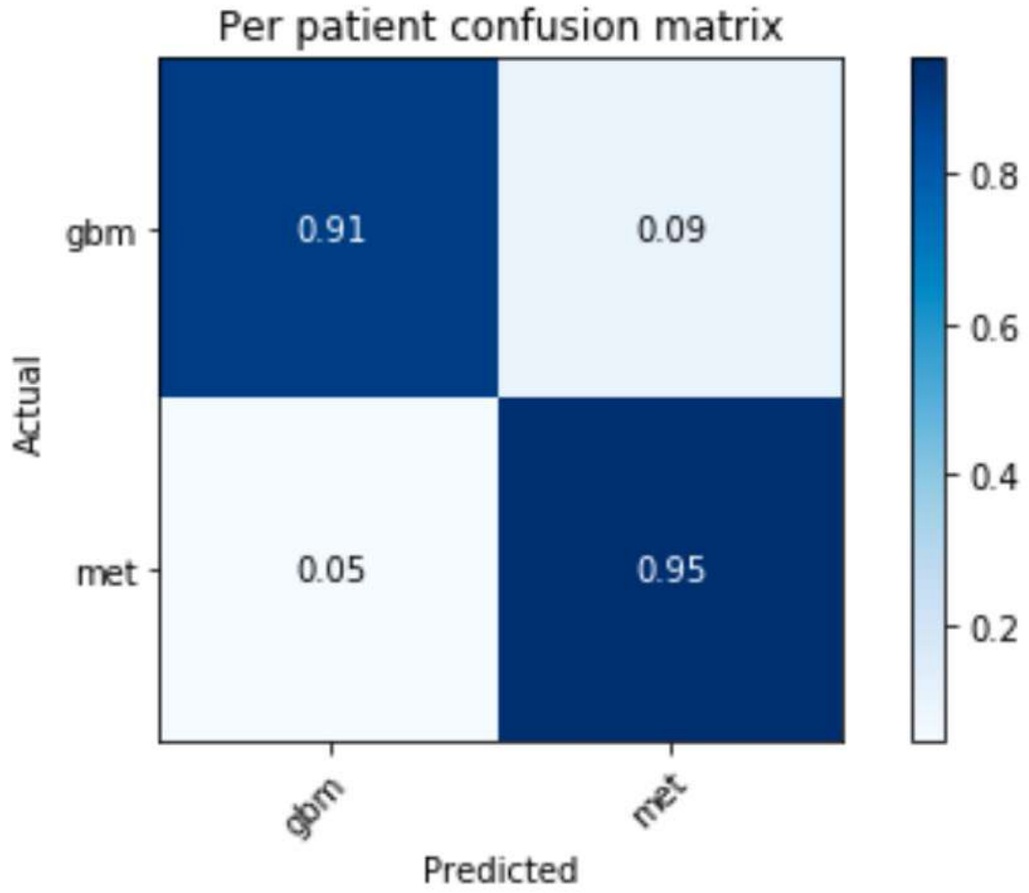
	SID	RID
ResNet34	0.823357	0.991495
ResNet50	0.839090	0.993298
ResNet101	0.824393	0.993098
DenseNet121	0.814449	0.990236
VGG19	0.828771	0.990423

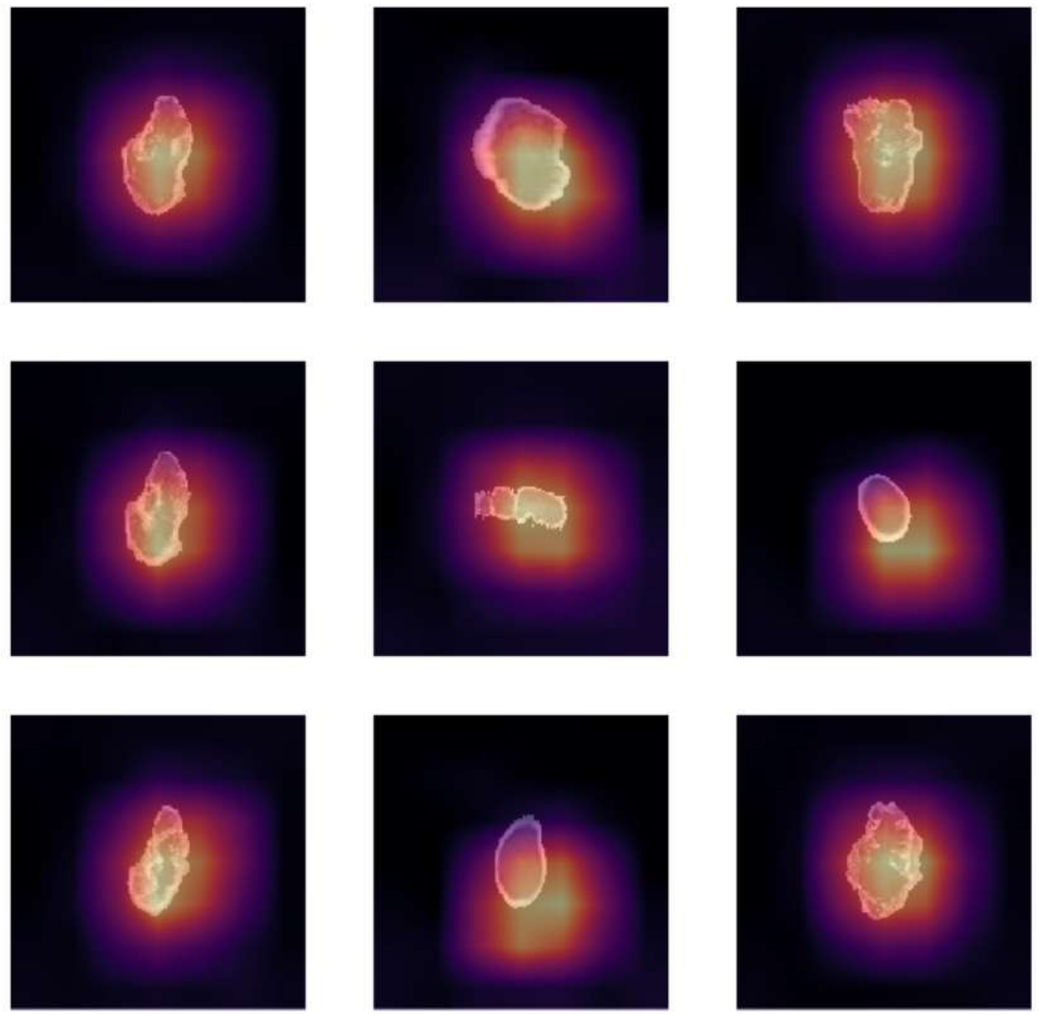
Results with “whole T1+Gd sequence”



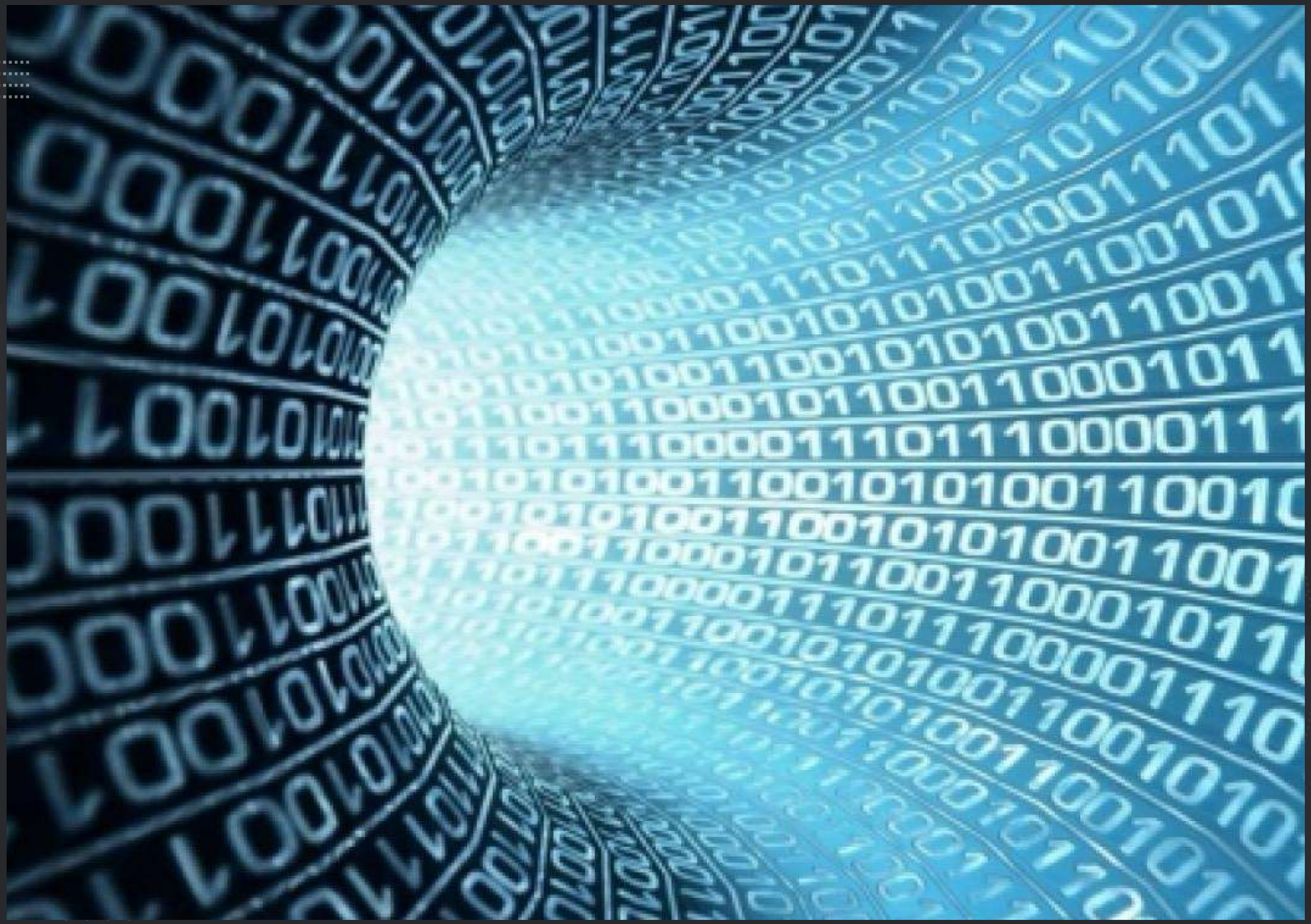


Results with “only tumor segmentation”





Human wins!
And don’t trust machines



- 93 GBM patients with 3D pretreatment T1+Gd sequence.

- 0 brain metastasis patients.

TOG project

CENTRO COLABORADOR	NUMERO DE PACIENTES
Hospital General Universitario de Ciudad Real	113
Hospital Universitario 12 de octubre	92
Hospital Universitario Marqués de Valdecilla (Santander)	67
Hospital Virgen de la Salud (Toledo)	49
Hospital Regional Universitario de Málaga	48
Hospital Clínico Universitario de Salamanca	30
Hospital de Manises	6
Instituto Valenciano de Oncología	2
TOTAL	**407**

- Clinical data (age, sex, treatments, etc.).
- 407 pretreatment sequences (at least 3D T1+Gd).
- All manual validated segmentations on 3D T1+Gd.

METMATH project

CENTRO COLABORADOR	NUMERO DE PACIENTES
Instituto Valenciano de Oncología	70
Hospital MD Anderson Cancer Center (Madrid)	21
Hospital Universitario HM Sanchinarro (Madrid)	13
Hospital Regional Universitario de Málaga	4
Hospital Clínico Universitario de Salamanca	2
TOTAL	**110**

- Clinical data (age, sex, treatments, etc.).
- 1033 follow-up sequences (at least 3D T1+Gd).
- 624 manual validated segmentations of 208 BMs on 3D T1+Gd.

Doctor Connor?

Perez García, Víctor M

Pérez Beteta, Julián

Arana, Estanislao

MATHEMATICAL ONCOLOGY LABORATORY

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http://matematicas.uclm.es/molab

Thank You